MARS ONE

HUMANITY'S NEXT GREAT ADVENTURE

INSIDE THE FIRST HUMAN SETTLEMENT ON MARS

EDITED BY NORBERT KRAFT, MD
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FOREWORD

A young man appeared in my office. Yes, he had made an appointment with my secretary to meet me. He had heard about my interest in futuristic applications of science and science fiction. He, and a few companions, had some rather bold ideas that he wanted to unfold for me, and he wanted to learn how I would react.

If you are in a field of science like mine, people with "new ideas" show up all the time. Those ideas are usually "new" and "original" indeed, but completely out of touch with the real world. Usually, they are based on hopelessly ill-informed perceptions of what real science and technology are about, and there is not much I can do for such people other than advise them to learn much more about what professionals have to say regarding the topics they are so thrilled about before bothering me again.

And here was a guy talking about human colonies on the planet Mars. The colonists would travel for approximately seven months from Earth to Mars, four people at a time, and they would stay there, keeping themselves alive as long as they were able, without the slightest glimmering of hope for a safe return home to Earth but ensured of eternal fame in the history of mankind.

The date: April 27, 2012.

The man's name: Bas Lansdorp.

"All basic science you need already exists," he told me. "All you need to do is some more research to combine it all. Use spacecraft designs that have already been made, scale them up a bit, and test them thoroughly." It would take just about ten years to prepare for the first

colonists to go, according to his calculations, and the cost would be around 6 billion American dollars.

Now this, I thought, was entirely unrealistic. It's true that basic science did not put any fundamental obstacles in his way. In principle, all this was possible. But those numbers? Ten years? Six billion dollars? "You better put an extra zero behind them," I said. Building a big particle accelerator already costs more, as do large railway projects, let alone the development of a new military aircraft.

But he was sure he had done his calculations correctly. Yes, his estimates were optimistic; if things did not go as planned, it would take longer and cost more, he admitted. "But we will be a private enterprise. We will not depend on government declarations and political hassles. We'll make our decisions swiftly."

It still sounded very optimistic indeed. But when hearing a thing like this, I do not only listen to how it sounds. I also search for grave mistakes and gross misperceptions. Here, these were lacking. It seemed that he had considered all major issues involved. How do people survive for seven months in a spaceship to Mars? How does a spaceship with people in it land on Mars? And, after they have landed, how do you provide them with water, energy, food, and a lasting atmosphere? How should they communicate with mission control on Earth? How do you protect them against major hazards, such as cosmic radiation and energetic solar bursts, but also more mundane things such as poison and dust? How will the colonists handle numerous threats, such as malfunctioning devices, medical problems, life-threatening shortages of almost any one of their basic needs, and so on?

Not only had he considered those concerns, but already plans had been made for assembling the funds needed for the project. "It will be a unique accomplishment for humanity. Cash will flow," he claimed.

His answers were optimistic but not crazy. Indeed, in principle, one can take care of all major aspects of journeys to Mars. Then something happened that I had not anticipated: I became enthusiastic about his ideas. If it is at all possible, humans should be enabled to travel to Mars, though I still think that it will take longer, perhaps much longer, than

ten years before a manned spaceship can lift off toward Mars, and that the cost will be more than the estimated 6 billion.

If man can go to Mars and establish settlements there, then the rest of the solar system comes into view. What about the moon, some of the larger asteroids, the large moons of Jupiter and Saturn? What about the cold, remote regions of the outer solar system?

"I will be your Ambassador," I said, "but I won't cover the financial part. I never did understand such calculations." Because if it can be done, it doesn't matter how long it takes. I see a multitude of good and interesting developments that could be triggered by this activity. Even if Mars One never succeeds in putting people on Mars itself, the organization will constantly arouse people's imagination about Mars, trigger new investigations and investments in all those technical issues associated with manned Mars missions, and otherwise pave the road in many ways. Humanity will go to Mars, even if we cannot yet say exactly when and how.

Naturally, there are still many questions to be answered. One essential ingredient of the plan is that unmanned machines will precede the manned missions. Robots will be employed to do as much as possible before the colonists arrive. Robots? What can they do? Does Mars One realize how difficult it is to persuade robots to do just about anything? These will have to be intelligent machines, and they don't exist yet. This is going to be a tough problem. Then, when they arrive, the colonists will be surrounded by an extremely hostile environment, dependent on highly advanced technology as much as their own ingenuity. Much of their habitat will have to be covered with thick layers of earth for protection.

Often, as well, the question is raised: What good will sending people to Mars be for science? Many scientists regard manned spaceflight as a ludicrous waste of money and effort. Scientific exploration can be done much better and much cheaper by robots, they emphasize. Indeed, this is true for most scientific questions being investigated now. But what is it that makes planets and moons so interesting in the first place? Could it be related to the remote possibility that humans might someday set up camp there?

To my mind, manned exploration of the distant parts of the solar system would be one marvellous scientific experiment all in itself. Can a lasting biological ecosystem be set up on places other than Earth, places where such ecosystems do not exist at present? How will such systems evolve there, together with the species *Homo sapiens*? Can they, in unison, defend themselves against numerous external threats? Will humans be strong enough to persevere, even if mishaps do take place?

How far can we go? Or will the task of colonizing these places be taken over by intelligent robots altogether?

I am Mars One's ambassador because this attempt is the first of its kind. It is going considerably further than any of its more amateuristic predecessors. Maybe it won't succeed in its primary mission, but whatever errors it makes now will be extremely instructive for the next initiatives. In that case, we can still maintain that Mars One is paving the road to the future.

This book is one of the instruments for doing so. It discusses the skills human colonists will need to comply with all conceivable eventualities that they may encounter. Colonists will need not only suitable air, water, food, and shelter, but also the strength to endure complications in their social relationships, challenging workloads, loneliness perhaps, and other sufferings. They will need resistence and perseverance.

One thing they will enjoy for sure: the first colonists will have earned fame and the admiration of the millions back on Earth watching them, much like Olympic athletes. Their successors on Mars, also, will become famous for their attempts to expand and strengthen their colonies. They all will be the ones who did it.

—Gerard 't Hooft

INTRODUCTION

We have been orbiting humans around Earth for more than half a century. We have landed on the moon and sent spacecraft to explore various near and distant planetary objects in our solar system. The next logical place for humanity's great adventure is Mars. It's the only planet we know of with an abundance of a key life-critical substance—water—and although located much farther away from Earth than our moon, it is close enough for humans to make the trip, even with our current technology.

Mars One is a nonprofit organization, based in the Netherlands and international in scope, whose goal is to establish a permanent human settlement on Mars. Why do this? Because it is the next giant leap forward for humankind; a stepping-stone for the human race on its unyielding quest to explore the universe. Human settlement on Mars will aid our understanding of the origins of the solar system, the origins of life, and our place in the cosmos.

Sending a manned mission to Mars is a fantastic adventure. Imagine the incredible feeling of being the first human in history to step out of the capsule and leave your footprint on the surface of Mars. This feeling of amazement will be experienced by not only the astronaut but also by his or her audience: all those watching from back home. After all, many of those who observed Neil Armstrong land on the moon so many years ago still remember the details—where they were, who they were with, and how they felt when it happened. This will be our moment, in 2027. Imagine, too, something more—what it would be like to live on another planet, millions of miles from Earth, and look up

into the night sky, knowing that one of the "stars" is actually the planet on which you were born.

And what about humankind's good old-fashioned curiosity? What can studying Mars teach us about Earth's history? Is there viable life already living on the Red Planet? These are a few of the many burning questions for scientists worldwide to ponder and seek to answer.

Progress is another reason to establish a permanent human settlement on Mars. A mission to Mars will jump-start massive developments in areas such as recycling, solar energy, food production, and medical technology, to name just a few.

Next to planet Earth, Mars is the most habitable planet in our solar system. Its soil contains water to extract; it isn't too cold or too hot; there is enough sunlight to power solar panels. Gravity on Mars is 38 percent that of our Earth and, although that may sound low, many believe it is a sufficient amount for the human body to be able to adapt to. Mars has an atmosphere (albeit a thin one) that offers protection from cosmic and the sun's radiation. Its day-night rhythm is very similar to Earth's: A Mars day is twenty-four hours, thirty-nine minutes, and thirty-five seconds long.

In contrast, consider the only other two celestial bodies in orbit near Earth: our moon and Venus. There are far fewer vital resources available on the moon, and a moon day lasts one month. It also does not have an atmosphere to form a barrier against radiation. Venus is a veritable purgatory. The average temperature is more than 400 degrees, the barometric pressure is the same as if you were located 900 meters (about one-half nautical mile) underwater on Earth, and there are occasional bouts of acid rain. Venus has nights that last for 120 days. Humans cannot live on Mars without the help of technology, but compared to Venus it's paradise!

As of this writing, Mars One's first unmanned mission to Mars, to prepare a habitable settlement, is scheduled to depart in 2020. The first four-person crew will depart for its one-way journey to Mars starting in 2026. But the arrival of the first four to inhabit Mars is just the beginning of this great adventure. Those astronauts will be followed by

subsequent crews, which will depart every twenty-six months thereafter, leading the Martian base to grow eventually into a small village. At first, expansion will be limited due to provisions, oxygen, and water. Other landings will provide everything the settlers might need to expand the colony: new living quarters, solar panels, and plastic components. The settlement will continue to develop as those inhabiting it become architects of their own environment.

After Mars One's official announcement, a large number of candidates registered their interest in being a member of the first team to settle on Mars. In 2013, nearly a quarter-million applicants filled out Mars One's online registration. As of February 2015, that number was whittled down to one hundred, and, in 2016, the selection process will reduce that number to twenty-four candidates—those who will receive a formal, full-time employment offer followed by a ten-year training schedule for Mission Mars. Both the selection and training process will be filmed and shared with the world. (To read more about the selection process—the journey from the original applicant pool to the remaining one hundred and the work that remains—please see "The Mars One Selection Process" on page 257.)

In this anthology, we, the editors and core members of the Mars One Selection Committee, aim to answer a number of questions about the requisite skills the members of this first crew to Mars must have, along with some reflections about the effects that continuous filming may have on them. We also share a selection of answers the applicants gave about their lives on Earth and how they may potentially live their lives with others on Mars.

To answer these questions, we've divided this book into four main parts to which well-known experts—from former NASA employees to multi-decade veterans in the spaceflight field—have contributed their learned opinions, providing valuable information and insights about the unknown variables the settlers could face across the many possible scenes of this challenging adventure.

Part I discusses the "hard" scientific skills, falling across a broad range of domains, the crew members will be expected to possess:

technical expertise for maintaining the spacecraft and the habitat, along with the aptitude and inclination to innovate solutions to unforeseen problems, with limited tools and supplies; and the knowledge, techniques, and confidence needed to be able to provide their own medical care, when necessary, and to keep healthy and fit.

Part II discusses the so-called soft skills that are critical for facilitating team cohesion despite the complex interplay of interpersonal dynamics among multicultural, gender-mixed crew members who may differ widely in age.

Part III looks at the unique circumstances in which the crew will be learning and practicing these skill sets—in front of the cameras, with their actions projected to viewers worldwide—and at the impact continuous filming could have on the candidates and their audience.

Part IV imagines a typical workday on Mars: What would it be like? How might one's leisure time be spent afterward? We'll also touch on the political and legal complexities that surround colonizing another planet.

One thing is certain: Human beings will visit the planet Mars—orbit around it, land on it, and maybe even settle there—and we have to be prepared for this. Within this anthology, we, the editors and core members of the Mars One Selection Committee, will take you through the key stages of the Mission Mars adventure, and we hope you will not only enjoy reading about them but also become better informed about the multifaceted dimensions of fulfilling this challenge!

—The Editors